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California Building Standards Commission
915 Capitol Mall, Suite 200
Sacramento, CA 95814

Re: Additional information substantiating the potentially significant public health, consumer protection, and environmental effects of adopting PEX pipe for potable water use.

Chair and Members of the Commission:

This letter submitted on behalf of the California Pipe Trades Council provides additional information for the Building Standards Commission to consider in approving the use of PEX pipe for potable water in California. I wrote two earlier letters on this subject, dated July 23, 2001 and April 3, 2002, which were submitted to the Commission. Those letters described several reasons why the Commission would need to consider the potentially significant public health, consumer protection, and environmental effects of adopting PEX pipe for potable water use. I concluded that the Commission would need to obtain information and subject it to an independent analysis.

1. Wirsbo Disclosure in Defren v. Trimark Homes.

The PEX pipe industry has not cooperated with the Commission and has not provided key information about the material. Nonetheless, some new information has come from a series of documents in a lawsuit filed in Arizona. One document was submitted by Uponor Wirsbo, a major PEX manufacturer, as third-party defendant in Defren v. Trimark Homes (Arizona). The material in the disclosure is referenced by the Bates number, e.g. WIRS0265.

This manufacturer disclosure substantiates the chemical leaching and chemical permeation issues raised in my earlier letters. The disclosure also indirectly confirms the polymer oxidation and product reliability issue.

Wirsbo is the manufacturer of AQUAPEX and is one of the largest North American PEX distributors. AQUAPEX is made from PEX-A, cross linked polyethylene manufactured through the Engle method. The Engle method involves extruding the pipe resin with a peroxide catalyst and other additives.

According to her complaint, plaintiff Joyce Defren purchased a house from Trimark Homes in Scottsdale, Arizona. The house was plumbed with AQUAPEX. Ms. Defren found the water to have a bad taste and she was concerned about the health effects of chemicals in the water. When the water was tested by a lab it was found to have several organic chemicals present: Methyl-tert-Butyl ether (MTBE), tert-Butyl alcohol (TBA), and various benzene-type aromatic hydrocarbons.

Wirsbo claims that the MTBE and TBA are "by-products of the manufacturing process" (Uponor Wirsbo initial rule 26.1 disclosure statement, p. 3).

Wirsbo claims that the benzene chemicals were the result of a termiticide formulation permeating the pipe and that the company is not at fault because it warns against exposing pipe to potentially permeating compounds: "The permeable characteristics of cross-linked polyethylene tubing prohibit installation in soil or ground water contaminated with solvents, fuels, organic compounds or other detrimental materials". (Wirsbo disclosure statement, page 2.)

2. PEX permeation is a significant problem.

I have raised permeation as a potentially significant environmental and health and safety effect. Information from the Arizona lawsuit, the, Plastic Pipe and Fittings Association and the Plastic Pipe Institute bears out my concerns. In my July 23, 2001 letter, I said,

> "Permeation is the phenomenon where relatively low molecular weight substances migrate through a seemingly solid polymer barrier. Permeation is a concern where the ground and groundwater are contaminated with petroleum compounds, with the gasoline additive MTBE, or with pesticides, particularly termiticides. Although most domestic plumbing will be within the structure itself, the approval considered by HCD includes external exposure from the water metered to the structure or under slab for slab on grade home construction. The latter is a particular concern because of the requirement for treating the sub-slab soil with termiticides in some geographic locations. HCD should request and review laboratory or field test data for PEX permeation. Note that the different types of PEX have different chemical cross-linking characteristics and would be expected to have different permeation behavior."

In Thermoplastic Piping For The Transport Of Chemicals, January 2000, The Plastics Pipe Institute (http://www.plasticpipe.org), states, "In general, chemicals that affect plastics do so in one of two ways. One effect is chemical solubility or permeation. The other is direct chemical attack. In the case of solubility or permeation, physical properties may be affected, but the polymer molecule

structure itself is not chemically changed, degraded or destroyed. In solubility or permeation, gas, vapor, or liquid molecules pass through the polymer, typically without damaging the plastic material itself. ... Permeation may do little if any harm to the material, but it may have application-related effects. The permeating chemical may transfer into a fluid on the other side of the pipe. In general, thermoplastic pipes should not be used where a permeating chemical could compromise the purity of a fluid such as potable water inside the pipe ..."

The PEX Industry acknowledges the limitation and warns "Do not allow tubing to come in extended contact with any of at least the commonly encountered construction materials listed below: (This list is not all-inclusive.) Pipe thread sealing compounds; Fire wall penetration sealing compounds. Exception: water soluble, gypsum-based caulking; Petroleum-based materials such as: Kerosene Benzene Gasoline, Solvents, Fuel Oils, Cutting Oils, Asphaltic Paint, and Asphaltic Road Materials." and "Do not place any PEX tubing in heavily contaminated soils or other heavily contaminated environments." (The Plastic Pipe and Fittings Association, 2002 Installation Handbook: Cross-linked Polyethylene (PEX) Hot and Cold Water- Distribution Systems, page 4.)

The Engle method PEX-A is usually more highly cross-linked than the other types, PEX-B, the silane method which produces silicon-oxygen cross link bonds, and PEX-C, where cross linking is initiated by gamma or electron beam radiation. Thus the permeation liability for AQUAPEX will be shared by all PEX pipe.

3. There is a high risk of PEX permeation in California from MTBE and other fuel contamination.

Soil and ground water contamination from petroleum fuels is widespread in California. Most of the toxic contaminated sites in the state are leaking underground storage tanks. Despite a major effort at replacing tanks and remediating soils, large areas are still contaminated with gasoline and other fuels.

This problem was greatly exacerbated by the adoption of MTBE as a motor vehicle fuel additive when it was found that MTBE is far more mobile in ground water and that even low levels of water contamination is noticeable. "It is possible your water would taste and/or smell like turpentine if MTBE is present at levels around or above 20-40 ppb (some people may detect it at even lower levels)." (US EPA at http://www.epa.gov/mtbe/water.htm) Ppb stands for parts per billion, also expressed as micrograms per liter ug/L.

Possible contamination is widespread. "Contamination of drinking water sources can occur from leaking underground and above ground fuel storage tanks, pipelines, refueling spills, automobile accidents damaging the fuel tank, consumer disposal of "old" gasoline", emissions from older marine engines, and

to a lesser degree, storm water runoff, and precipitation mixed with MTBE in the air." (US EPA op. cit.)

Many gasoline components such as benzene are carcinogens. MTBE is suspected as a human carcinogen. "EPA's Office of Water has concluded that available data are not adequate to estimate potential health risks of MTBE at low exposure levels in drinking water but that the data support the conclusion that MTBE is a potential human carcinogen at high doses. Recent work by EPA and other researchers is expected to help determine more precisely the potential for health effects from MTBE in drinking water."

California summarizes Health Hazards of MTBE at http://dbw.ca.gov/MTBEFactSheet.htm

"A. The Office of Environmental Health Hazard Assessment set a public health goal for MTBE of 13 ppb (advisory, not enforceable) based on its potential to be a human carcinogen.
B. U.S. Environmental Protection Agency: "MTBE is an animal carcinogen and has human carcinogenic hazard potential."
C. University of California study: "MTBE is an animal carcinogen with the potential to cause cancer in humans."
D. White House National Science and Technology Council report: "There is sufficient evidence that MTBE is an animal carcinogen and that the weight of evidence supports regarding MTBE as having a carcinogenic hazard potential for humans."
E. National Toxicology Program (NTP) voted 6 to 5 against listing MTBE as a chemical likely to cause cancer in humans.
F. Science Advisory Board of the Safe Drinking Water and Toxic Enforcement (Prop 65) in December was split on whether to list MTBE as a chemical clearly shown to cause cancer.
G. Centers for Disease Control study (in Alaska) and anecdotal reports of acute effects of MTBE exposure include: headache, nausea or vomiting, burning sensation in the nose or mouth, cough, dizziness, eye irritation and disorientation.
H. CA Dept of Health secondary drinking water standard for taste and odor is 5 ppb. In higher concentrations MTBE smells like turpentine and tastes like paint thinner."

The extent of concern over MTBE is great. EPA states, "Because MTBE dissolves easily in water and does not "cling" to soil very well, it migrates faster and farther in the ground than other gasoline components, thus making it more likely to contaminate public water systems and private drinking water wells. MTBE does not degrade (breakdown) easily and is difficult and costly to remove from ground water." "MTBE is generally more resistant to natural biodegradation than other gasoline components." (EPA op. cit.)

So far the concern is for contamination of wells and public water supplies. The assumption is that the public will be safe if the water supply is safe. That situation would change drastically if thousands of new homes are built with under slab PEX piping subject to permeation.

The evidence that MTBE may permeate PEX is significant. The PPFA Installation Handbook states that materials such as Gasoline, Kerosene and Fuel oils should not be allowed contact with PEX, and that PEX should not be placed in any heavily contaminated soils. MTBE has been a component of gasoline, which can contaminate soil. The Arizona lawsuit demonstrates that MTBE was found in water inside PEX piping. The manufacturer of that piping claims that the MTBE is a byproduct of production, which would be a threat to public health and safety. Alternatively, the MTBE could have come from contaminated soil, which would also be a threat to public health and safety. These are significant risks for California.

4. There is a high risk of PEX permeation by Termiticides in California.

The heart of Defren v. Trimark is the substantial permeation of the PEX potable water pipes by termiticide formulation in the soil. Although the affected home is in Arizona, the same under-slab soil treatment is widely practiced in California.

Termiticides are both applied prior to new construction and frequently after construction. As more toxic compounds have been excluded from use, the need for more frequent application has increased. Note that it is not simply the active ingredient that is of concern, but the petroleum based solvents needed for these inherently insoluble compounds. It is likely that it was the "inert" petroleum carrier for the active pesticide ingredient that contributed the high levels of substituted benzenes to the water in Ms. Defren's house (see below).
Nearly every home in California is potentially affected. The volume of termiticide applied is staggering. Lewis (UC Berkeley) summarizes,

"In the United States control and damage repair costs due to subterranean termites exceed $5 billion per year (Su Scheffrahn 1990). In California, these costs exceeded $300 million per year a decade ago (Brier, Dost, & Wilcox 1988). Chemical barriers have been the dominant means of protecting the multi-billion dollar national investment in wood-in-service for more than 50 years. Since the early 1940's when chlorinated hydrocarbons were shown to have biological activity against insects, chemical barriers have been the mainstay of the pest control industry in combating subterranean termite infestations. In California, the risk homeowners face in having a termite infestation is substantial; 30% of all structural pest inspection reports (over 1.5 million conducted per year) reveal signs of active subterranean termites (Brier, Dost, & Wilcox 1988).

"In California, over 7.6 million liters (more than 76,000 kg of active ingredient) of termiticides were applied for termite control in the 6 San Francisco Bay Area

counties from 1986 - 1990 (D. Carver, unpublished data). Literally all of these termiticides are placed under or adjacent to structures occupied by people at a time when public concern over toxic chemical usage is increasing." Field Comparison of Sand or Insecticide Barriers for Control of Reticulitermes spp. (Isoptera: Rhinotermitidae) Infestations in Homes in Northern California, Vernard R. Lewis, Michael I. Haverty, Douglas S. Carver, and Calvin Fouche. Emphasis added.

The biggest problem with termite control under slab is pipe penetrations which must be left loose to avoid damage to the pipes. Pest control operators inject termiticide directly around the pipes. There is no way that this post construction exposure can be avoided.

If termiticides permeate PEX, as alleged in the Arizona lawsuit, then use of PEX would be a significant health and safety and environmental problem in California.

5. The BSC should evaluate the potential magnitude of the permeation problem before adopting PEX as a plumbing material.

Wirsbo's defense in Defren v. Trimark Homes was "Where such [contaminated] conditions are suspected, chemical analysis of the soil or ground water should be performed before installation". This is not a realistic requirement. The State of California might be able to impose a requirement for soil testing as mitigation for potential permeation impacts on PEX installations. But this would not address the problem of contamination that happens after the pipe is installed. A homeowner with PEX under slab cannot be barred from remedial termite work.

The BSC is the only body that can consider the full scope of the permeation problem in California and decide what limitations are needed. The manufacturer's approach is to disclaim any liability – that does not protect the consumer.

6. Chemical leaching from PEX has not been disclosed.

Chemical leaching is when substances in the pipe leach into the drinking water. There has been no disclosure to the state of any leaching potential from PEX. Clearly industry knows of the leaching potential, has advised NSF International of certain known chemicals, and has reviewed its own tests.
Disclosure is critical to the state's ability for independent review. The state cannot rely on NSF certification alone. As stated in my July 23, 2001 letter,

"NSF performs a valuable role, but the state of California cannot delegate to NSF its own obligation for public health and environmental protection. The state of California needs to exercise its independent judgment in the course of CEQA compliance. The state can obtain information from third parties, but the state alone needs to determine the sufficiency and accuracy of that information, and

the state needs to make that information available to the public so that the public may be assured that the environmental process has been conducted completely and thoroughly.

"The state cannot rely on the NSF certification process to assure the protection of public health because:

1) NSF disclaims responsibility and specifically disallows governmental reliance on its standards.
2) NSF does not release the results of tests on the materials it certifies.
3) NSF's testing protocols may not be adequate to determine the potential for chemical leaching."

When forced by litigation in Defren v. Trimark Homes, Uponor Wirsbo did provide some chemical leaching test results. In its own tests of Ms. Defren's home, Wirsbo found a range of chemical leachate (by Spectrum Labs, St. Paul MN, WIRS 0001 to WIRS 0011 and by Orange Coast Analytical, Phoenix, AZ, WIRS 0044 to WIRS 0078.) Concentrations are reported, but the conditions under which the samples were taken are not known.

Aromatic Compounds
- n-Butyl Benzene
- 1,2,4-Trimethylbenzene
- numerous other alkyl substituted benzenes

Halogenated Compounds
- Bromodichloromethane
- Bromoform
- Chloroethane
- Chloroform
- Dibromochloromethane

Alkyl Compounds
- None reported,
- tert-Butyl Alcohol not specifically tested by Spectrum,
  - tested with a 10 ppb detection level by Orange Coast.

The benzene family concentrations were very high, with total concentrations of Tentatively Identified Compounds (TIC) in the range of 69.89 ppb ("Kitchen", WIRS0011) to 224.38 ppb ("Rear Hose", WIRS005). NSF finds Toluene, Methyl hexanone and isomers 54 ppb, DTBP and other unidentified organics, but not nearly at the concentrations of the substitute benzene TIC's. It is reasonable to conclude that these substances were introduced into the pipe by permeation.

The Halogenated Compounds are not expected normally in a polyolefin pipe product. They may have been present in the municipal water supply, but no blank sample was tested. When using purified water, NSF did find 2,2

Dichloropropane (1.7 ppb) and Chloroform (6.2 ppb, WIRS0115, 2.6, WIRS0124).

MTBE was not reported in Wirsbo's own tests, although acknowledged in the Initial Disclosure statement. NSF finds MTBE with normalized concentrations of 15, 17, 22 ppb. The EPA action level is 20 ppb. MTBE may be associated with the DTBP crosslinking agent added to pipe resin. Consistent with this, a Norwegian study, "VOCs leaching from PEX pipes gave an intense odour of test water. Several of the migrated VOCs were not identified. Oxygenates predominated within the identified VOC with methyl tert-butyl ether (MTBE) as a major component." Potential water quality deterioration of drinking water caused by leakage of organic compounds from materials in contact with the water. Lars J. Hem. Proceedings, 20 th NoDig conference, Copenhagen May 28-31 2002.

NSF requires specific testing of non-radiation cross-linked PEX for 2-Methyl-2-propanol, also known as tert-Butyl Alcohol (TBA). NSF 61 (adopted Feb 9, 2001), Table 3.1, Material-specific analyses. The reason is probably that TBA is the main product produced when the Engle method cross-linking agent Di tert-Butyl Peroxide reacts with the polyethylene in the raw resin.

TBA was not really part of the field testing. In the submitted material, NSF finds substantial amounts of TBA in leachate from Wirsbo PEX. The normalized concentrations are very large, ranging from 2300 to 5300 ppm.

TBA is generally not considered to be a highly hazardous compound, although National Institute of Health studies found some evidence of carcinogenicity in test animals, Toxicology and Carcinogenesis Studies of t -Butyl Alcohol (CAS No. 75-65-0) in F344/N Rats and B6C3F1 Mice (Drinking Water Studies), May 1995. (http://ntp-server.niehs.nih.gov/htdocs/LT-Studies/TR436.html).

We note, however, that the NSF results for TBA are very high. The State should make its own evaluation of how NSF sets the Single Product Allowable Concentration (SPAC) for this unregulated contaminant (Annex D of NSF 61), how the test results are scaled by assumptions of dilution in actual use, and how PEX products exceeding the SPAC can still be certified.

The halogenated compounds are largely known carcinogens. Are they in the pipe? Are the formed by residual chlorine reaction with pipe components? The BSC has a right to find the answers before approving PEX.

These tests raise significant questions about the safety and environmental impact of PEX. The Commission should obtain the answers to these questions prior to considering whether to approve PEX.

7. PEX oxidation and failure has not been addressed.

The organic molecules making up PEX pipe are subject to chemical degradation. The need to stabilize pipe resin during manufacture and in use is a driving chemical engineering problem for all plastic pipe manufacturers:

"Oxidation can weaken plastics, degrade oils, and destroy the integrity of coatings. These chemical changes can eventually result in performance and appearance changes in the material. Antioxidants are particularly important in plastics, since most plastics undergo one or more high-temperature processing steps, usually at the beginning of their life cycles. The Segment Plastic Additives of Ciba Specialty Chemicals has developed two basic types of antioxidants. One type -- processing stabilizers -- is designed to help the plastic survive the initial high-temperature processing step, whilst the other -- antioxidants listed below-works to prevent oxidation over the service life of the plastic article." (http://www.specialchem.com/storefronts/ciba/products/antioxydants.asp, emphasis added.)

The phrase service life of the plastic is key. The antioxidants have a finite life, determined by the magnitude of product exposure to oxidizers, heat, and sunlight. As stated in my July 23, 2001 letter:

> "Antioxidants function sacrificially. When the pipe resin containing the antioxidant is exposed to an oxidizer (chlorine or oxygen), the antioxidant molecules are preferentially degraded, thereby protecting the polymer molecule itself. Depending on the aggressiveness of oxidizer exposure and environmental conditions, the antioxidant additive in the pipe resin may be consumed rapidly. When the antioxidant is consumed, the polymer itself will be attacked with resulting polymer chain breakage, ensuing loss of strength and brittleness, and ultimately, premature mechanical failure."

The manufacturers clearly recognize this:

The Plastic Pipe and Fittings Association, 2002 Installation Handbook: Cross-linked Polyethylene (PEX) Hot and Cold Water- Distribution Systems, has two warnings about exposure to chlorine: "Do not use in swimming pool piping systems." and for chlorine disinfection, "Thoroughly flush all lines of the system at the end of the disinfection period. Failure to do so may damage the plumbing system."

Literature from the PEX manufacturers recognize that PEX cannot be left out in sunlight for long, as discussed below. This is because sunlight can oxidize the piping materials, which can lead to failure of the pipe. The PPFA Handbook (p. 6) warns, "avoid exposure to sunlight ", Wirsbo itself says less than 30-days (AQUAPEX Handbook, p. 25). The problem here is that sun (UV light) initiates

free radicals which threaten the integrity of the plastic and use up the antioxidant reserve capacity.

PEX manufacturers probably use different additives. Wirsbo uses Irganox 1076 (Ciba AO-76 , Chemical Name:Octadecyl-3,5-di-tert-butyl-4-hydroxyhydrocinnamate, CAS No.:2082-79-3) at roughly 0.5% by weight and some other compound not identified in the record. Some of the degradation products of Irganox 1076 may be detected at low levels in the water samples as the TIC's. The role of the related antioxidant, Irganox 1010, used in PB, was studied earlier by the state in the EIR on plastic pipe. Degradation products were observed which demonstrated the progressive loss of antioxidant capacity as the pipe ages. Lars J. Hem, op. cit., also observed "Degradation products from phenol-based antioxidants were major migrants from HDPE pipes." HDPE and PEX use similar antioxidants.

The BSC can bear in mind the tremendous financial loss and inconvenience to consumers from the failure of Polybutylene (PB), another polyolefin pipe material. The PEX industry is profiting from the demise of PB, but does not seem willing to openly discuss the known limitations of it product.

* * *

The accumulating evidence supports a decision by the Building Standards Commission to subject PEX to an independent and public review. Only then will the health and environmental interests of the public be served.

Sincerely,

Thomas S. Reid

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